Nothing new - [illegible] found the same results in RE [illegible] study in 1963 - [illegible] in the [illegible] JSF

HARE CREEK SPROUT STOCKING STUDY ON THE JACKSON DEMONSTRATION STATE FOREST

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INTRODUCTION

Relevance of the redwood sprout population, after logging, to the subsequent management of the coastal redwood/fir stands needs to be determined. Information about potential sprout stocking can affect planting levels and the species selected to augment the natural sprouts already in place. Regardless of the merits of redwood sprouts versus seedlings, the fact remains that managers often have to deal with a dense set of aggressive sprouts. How to take advantage of and deal with sprouting is the job that must be addressed.

Assessing the role that sprouts play in restocking stands after logging has not received much attention. Most writers and researchers of redwood have always pointed out that redwood reproduces from seed and sprouts. But, there is very little detailed information about the amount of sprouting regeneration, or about its eventual functional role in management of this forest type. Show (1932) reported that because of sprouting most second-growth stands were from 25 to 35 percent stocked, and in the examined cutover areas most of the second-growth was obviously sprouts. Later Person and Hallin (1942) noted that in Humboldt and Mendocino Counties an average of 7.8 percent of the stocking as sprouts. Yield tables of Lindquist and Palley (1963) reported that 65 percent of the second-growth redwood stems sampled in their data were sprouts.

Reasons for the difference between stocking values of the 1942 study relative to the 1963 view are related primarily to the sampling systems used in the studies, and the age of the sprouts considered. Random stocked milacre sampling, used by Person and Hallin on small regeneration, is the number of quadrats with sprouts as a percent of those examined. Most old-growth stands seldom had more than 30-40 redwood trees per acre. The probability of sampling stumps was low, and only a few areas contained redwood tissue that could sustain sprouting. However, because of its tenacity and ability to grow well in clusters, redwood will develop several stems in a small area. In this context a low percent of stocked quadrats can mean a much greater number of established trees per acre. Point samples used in the Lindquist and Palley study select sample trees by size; larger trees having a greater probability of being selected. Thus the yield table values show that redwood sprouts represent the most important part of the crop trees in the stands sampled.

Analysis of the regeneration 20 years after logging a clear-cut second-growth stand showed that most redwood stumps have sprouted (Henry,1985). The degree of sprout stocking is affected by the number and distribution of redwood stumps in the cut stand. There can be significant reduction of planting costs when an adequate number of sprouts are established. Choice of species to plant may also be influenced by the density of the redwood sprouts. Fast growing sprout clumps may retard small Douglas-fir seedlings. Finally, where redwood sprouting is successful the species composition of future harvests could be quite different from the current second-growth stands. Repeated cropping may create nearly pure redwood sprout stands unless major efforts are made to maintain other species.

cropping or burning.

OBJECTIVES

The main emphasis of this study is to develop a long range study of the role of sprouts in future management of commercial stands. Sampling the initial sprout population provides the basis for determining how the initial sprouts develop over time. Many of the original sprouts in the initial survey will die, and it is hard to judge now what the current sprout population will mean to the stand in 20 years. A set of mapped sample plots in three managerial options permits long range examination of sprout development following: clearcut without burning, clearcut with burning, selection cut with no slash treatment.

LONG TERM STUDY

Specific objectives outlined in the study proposal include the following topics.

1. To determine if silvicultural treatment affects the initial number and distribution of sprouts, and how these change over time.
2. To find if there are correlations between sprouting and the number and size of redwood stumps.
3. To develop a method of predicting sprout stocking prior to harvest, this can be useful for planning planting operations.
4. To establish a set of permanent plots with good documentation of the sprout portion of the stand regeneration. These plots can be used in later years for studies of precommercial thinning

FIELD METHODS

Three blocks of the Hare Creek 1983 logging operations were selected for sampling (figure 1). The blocks were all in section 26 T18N R17W about 5 miles from the coast and southeast of Fort Bragg. Descriptive values from the sample data show, an age of 80-85 years, with a redwood site index of 155-160. The species distribution of stumps was 59 percent redwood and 41 percent whitewood. Two blocks were clear cut; block C, a 20-acre parcel was unburned, and block D, a 10-acre parcel was burned six months after logging. The third area, block A, was selectivly logged and not burned. All logging was finished by the spring of 1984.

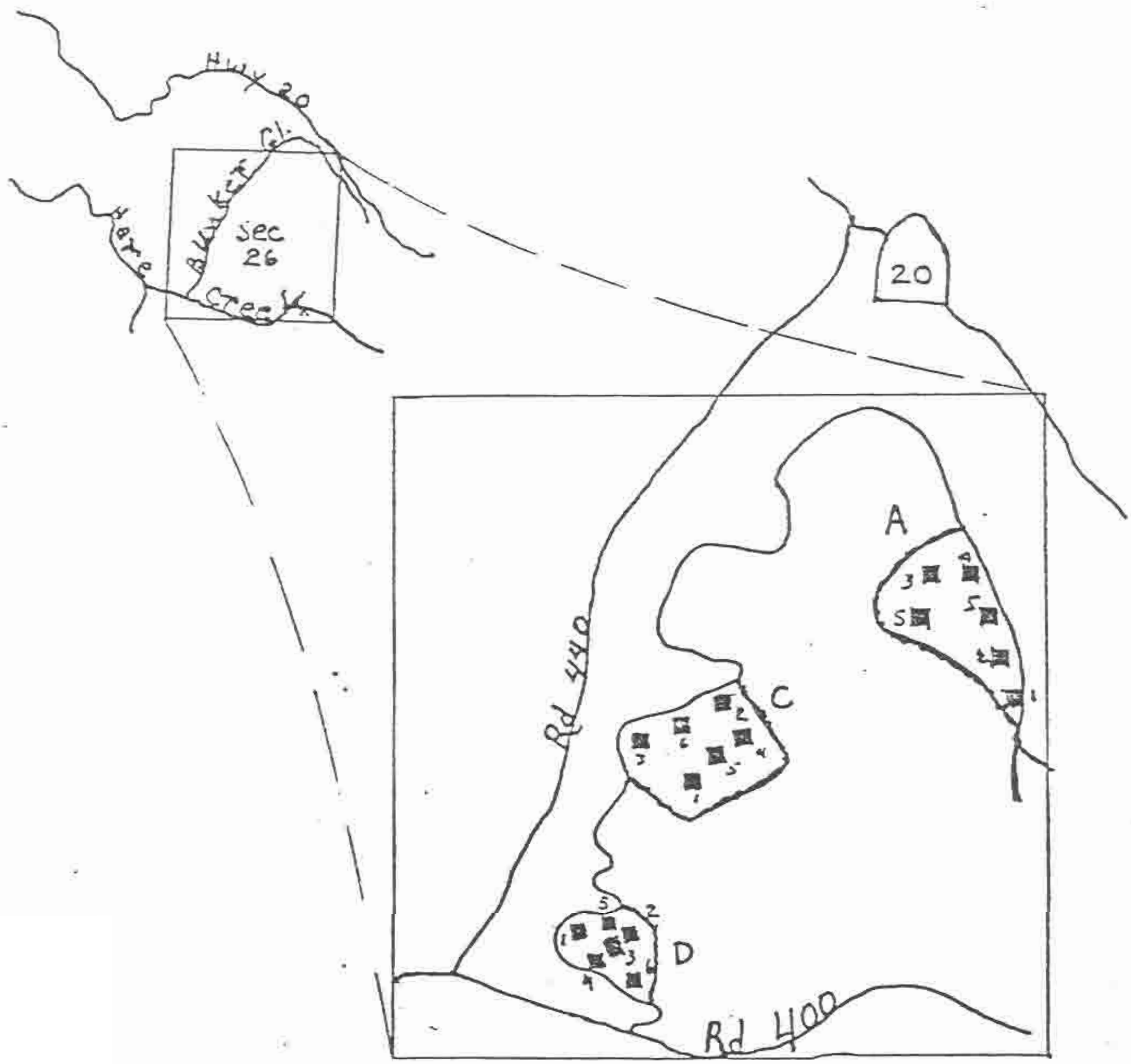


FIGURE 1. Location of the 1983 Hare Creek study, and layout of the sample plots.

All sprouts were approximately the same age when sampled. Burning of block D, autumn of 1984, destroyed the original crop of sprouts. The sprouts measured were those which arose in the 1985 growth season. Before the start of field work a layout of the plot distribution of each block was made. Some adjustment of plot location was required because of conditions found in the blocks. All field work in the unburned blocks was completed by May of 1985. Sampling the burned block was delayed until fall to give new sprouts an opportunity to have a seasons growth.

Six .4 acre plots were located in each block. Random numbers to define the northwest corner of each plot were drawn, then put on the X and Y grid of each block. Plots are 132 feet square, and posts are set at each exterior corner, and for a .2 acre (93.3 feet square) interior plot. Plots boundaries are oriented to the cardinal directions.

A transit measured the azimuth to each tree or stump inside the plot. A computer program computed the X and Y coordinates for each tree or stump from the northwest corner of the plot, where X and Y equal 0. To compute the coordinates of each stand element, relative to the transit, azimuth, slope angle, and slope distance are needed. The stumps coordinates are adjusted by the transit's to place the stump at its proper location on the plot's datum plane.

All trees and stumps within the plot boundaries were located and put on the maps. Also recorded were species, diameter (at breast height or stump top), stump height, number of crown and/or root clumps, estimated total number of crown and/or root sprouts, and height of tallest sprout. A clump was defined as a distinct group of sprouts on the stump separated from other sprouts. Sprout clumps noted but not associated with a stumps were also mapped. These location were assumed to have a stump of zero diameter and height.

RESULTS

Maps showing the distribution of stumps and associated sprouts in this study represent a major aspect of this work (an example, Figure 2). Maps and data will be used later to estimate how the initial sprouts developed into stems. The maps will allow future workers to know where all stumps with sprouts occurred in the initial inventory. Correlation of established stems to the initial sprout population will be useful in discussing the value of sprouts in restocking logged land. Some indecision about the value of sprouts comes from not being sure of the origin of older stems. Simply being near a stump is not sufficient proof of sprouting. Conversely a single stem without a visable stump does not mean that the tree is a seedling. Many clumps re-

FIGURE 2. Distribution of stumps in the .4 acre plot showing the species, location, and relative size.

HARE CREEK, BLOCK D, PLOT 1

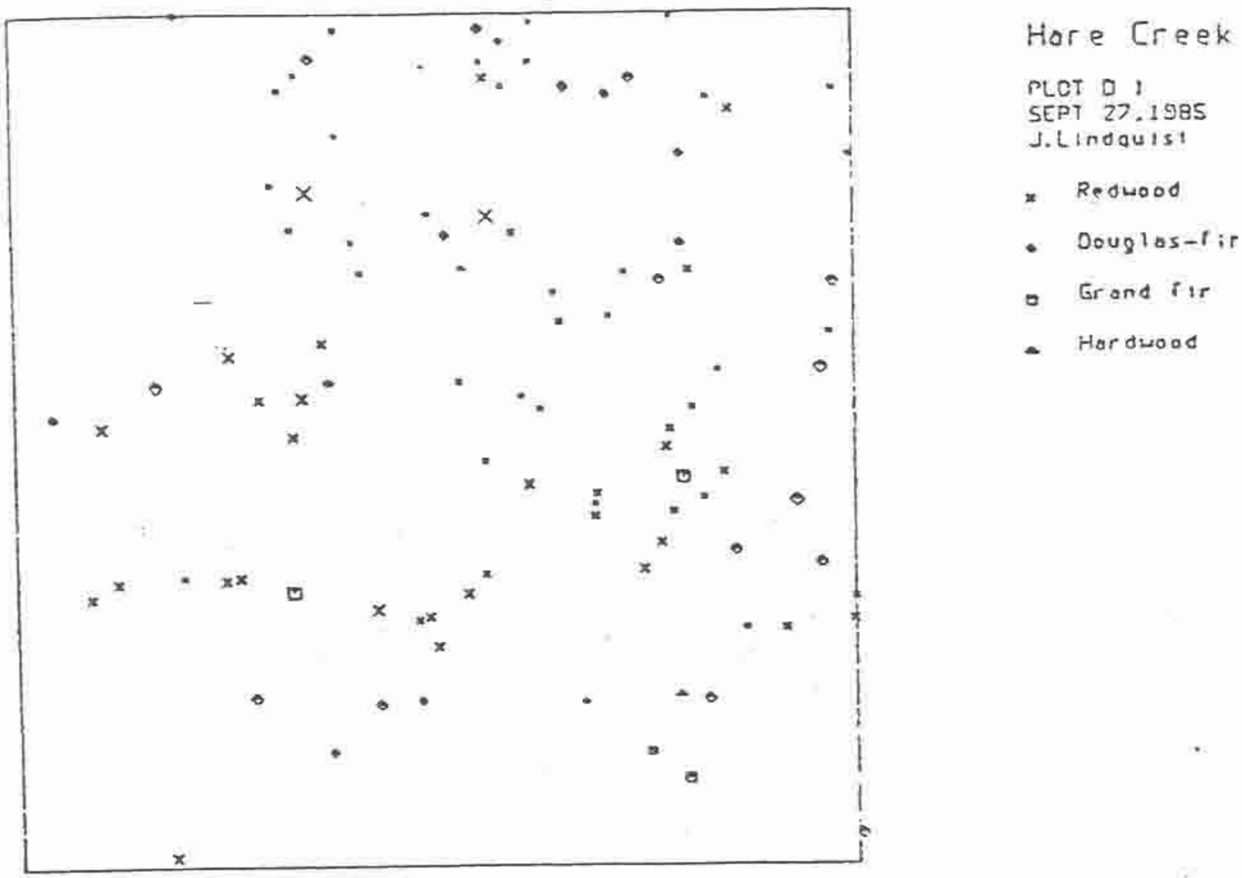


FIGURE 3. Distribution of stocked milacre quadrats. Numbers show the clumps in each of 400 quadrarts of each mapped plot.

HARE CREEK, BLOCK D, PLOT 1

0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	2	0	0	0	0
0	0	0	0	0	0	3	0	0	0	0	3	2	0	0	0	3	0	0	2
0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	2	0	0	0	0	10	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	1	0	0	4	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	3	0	0	0	2	0	3	0	5	0	0	0
0	0	0	0	0	0	0	2	0	0	0	0	0	3	2	0	0	0	0	3
0	0	0	0	0	6	0	0	0	0	3	0	0	0	0	0	2	0	0	0
0	0	3	0	0	4	7	0	0	0	0	0	5	0	0	3	4	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	6	3	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	5	11	0	4	2	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
0	1	2	0	1	8	0	0	0	0	4	4	0	0	0	4	0	0	0	5
0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	2	3	4
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ported in this study occur in locations where no stump was visable, or were on small stumps that would not show in 20 years.

Quadrat stocking

An auxiliary of the maps are printed graphics that show the number of clumps in each of 400 milacre quadrats in each of the 18 plots (an example, Figure 3). These displays show the spatial arrangement of stocked and non-stocked quadrats of each plot. A summary of the stocked quadrats, Table 1, reveals that quadrat size effects the percent of stocking. Average stocking of the 4-milacre quadrats is 30.8 percent, three times that of the milacre quadrats, 10.9 percent. In the three blocks the percent of stocked milacre quadrats is 3 percent more than that reported by Person and Hallin's 1942 study of cutover old-growth. The 11 percent of the milacre stocked quadrats represent 110 stocked quadrats per acre with an average of 390.2 clumps per acre. Recent results from the Whiskey Springs studies indicate that it is reasonable to expect at least one established tree per clump in 15 years. This projects to 390 redwood sprout stems per acre from the sprouting now in place.

Analysis of variance (ANOVA) of the percent of stocked quadrats, of both size quadrats, reveals no significant differences among the three treatments. Nor were there significant differences among the average number of locations with sprouts. Since the three blocks have no differences in the underlying sprout stocking we assume homogeneous initial stand stocking. Differences in sprout development, which may later arise, are then more closely related to treatment by cutting or burning.

Linear regressions that express the relation of clumps and sprouts to the percent of stocked quadrats are detailed in Table 5. The statistic, the correlation coefficient (R), shows the degree of association between two variables. Clumps per acre have the strongest relation to quadrat stocking, sprouts are less well correlated. All values of R, as tested by the critical values of R (Table 21, Zar, 1974), are shown to be significantly different from 0. These details show that there are positive linear relations of sprouting to quadrat stocking. A graphic view of these relations are also shown in Figures 4 and 5. Stocking of either size quadrat has a linear equation that is useful to estimate sprouting activity (Table 6).

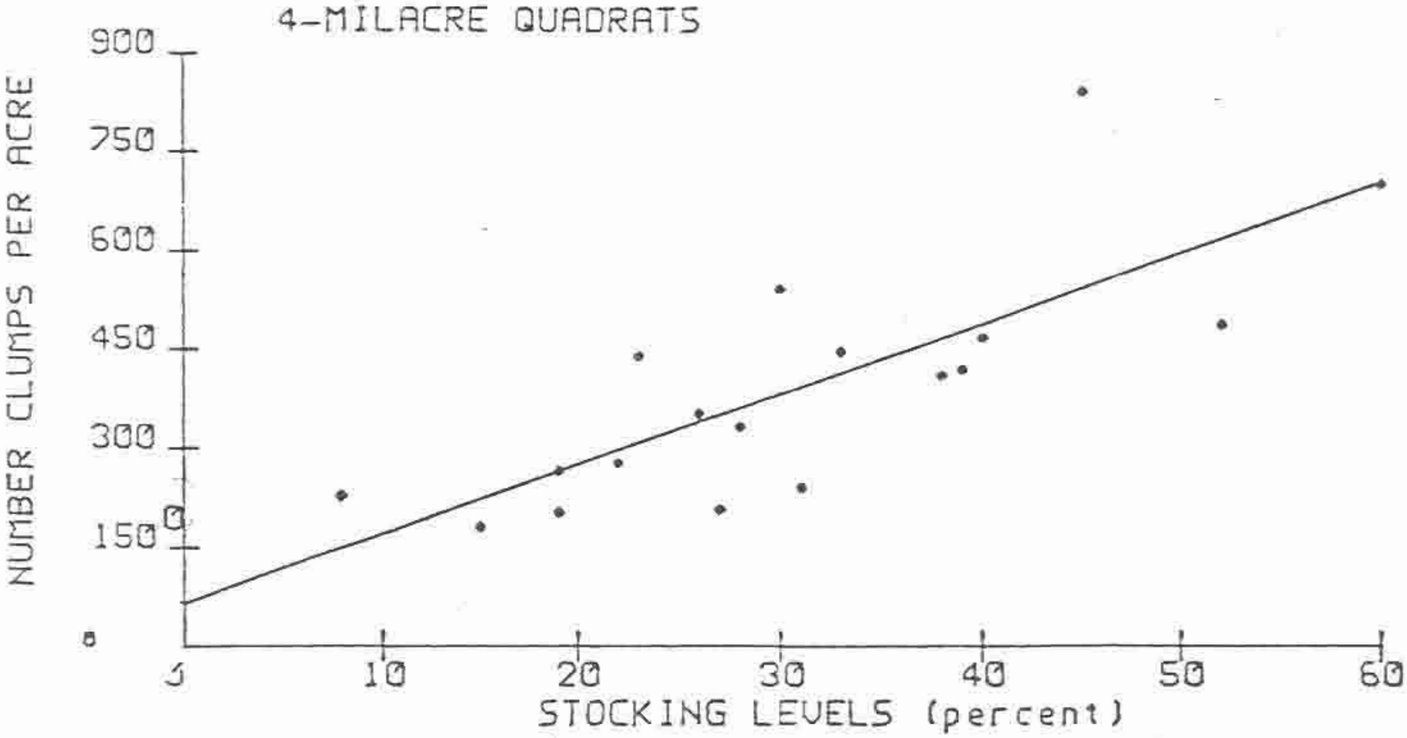
Levels of sprouting

Details that describe the sprout populations are shown in Table 2. Large standard deviations of sprouts and clumps occurs in blocks A and D as compared to block C. However,

Table 1. Summary of the stocked quadrats of the 18 mapped .4 acre plots of the 1985 Hare Creek Study. Number of sites with sprouts from map data expressed in per acre terms. Results based on 400 milacre and 100 4-milacre quadrats.

Plot	Sprt sites (No/acre)	1-Milacre (%)	4-Milacre (%)
Block C, clearcut unburned.			
1	165.0	13.2	39.0
2	87.5	6.0	19.0
3	145.0	10.7	28.0
4	105.0	8.5	26.0
5	117.5	7.8	23.0
6	157.5	11.8	33.0
Ave.	129.6	9.7	28.0
SD	31.0	2.7	7.2
Block A, selection cut unburned.			
7	90.0	6.0	15.0
8	100.0	8.5	27.0
9	110.0	9.2	31.0
10	327.5	25.0	60.0
11	225.0	19.0	52.0
12	90.0	6.5	19.0
Ave.	157.2	12.4	34.0
SD	98.1	7.8	18.1
Block D, clearcut burned.			
13	160.0	13.2	40.0
14	80.0	6.8	22.0
15	157.5	10.2	30.0
16	152.5	13.2	38.0
17	235.0	17.0	45.0
18	57.5	3.0	8.0
Ave.	140.4	10.6	30.5
SD	63.7	5.0	13.7
18 Plt.Ave	142.4	10.9	30.8
18 Plt. SD	66.6	5.0	13.2

FIGURE 4. Clumps per acre over quadrat stocking levels for 18 plots of the Hare Creek study 1984.



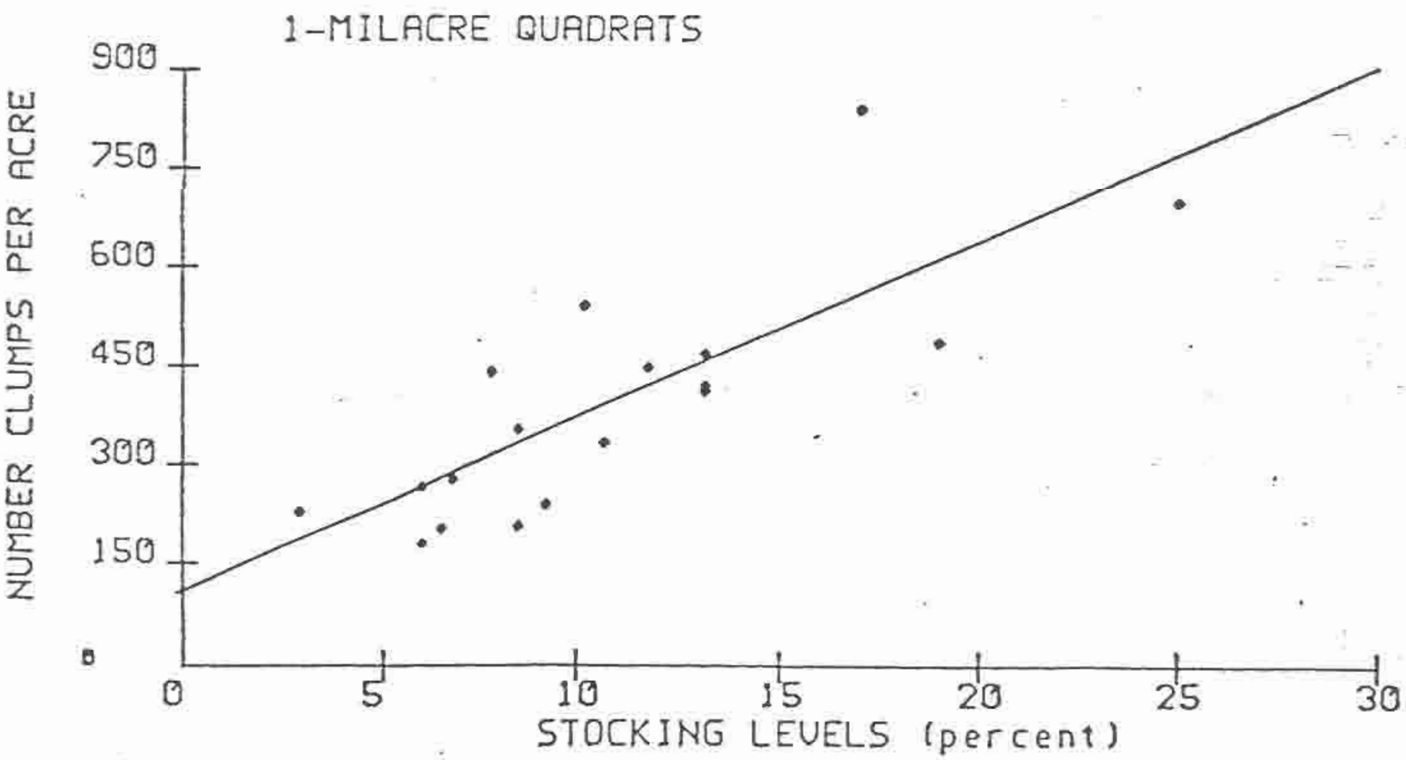


FIGURE 5. Sprouts per acre over quadrat stocking levels for 18 plots of the Hare Creek study 1984.

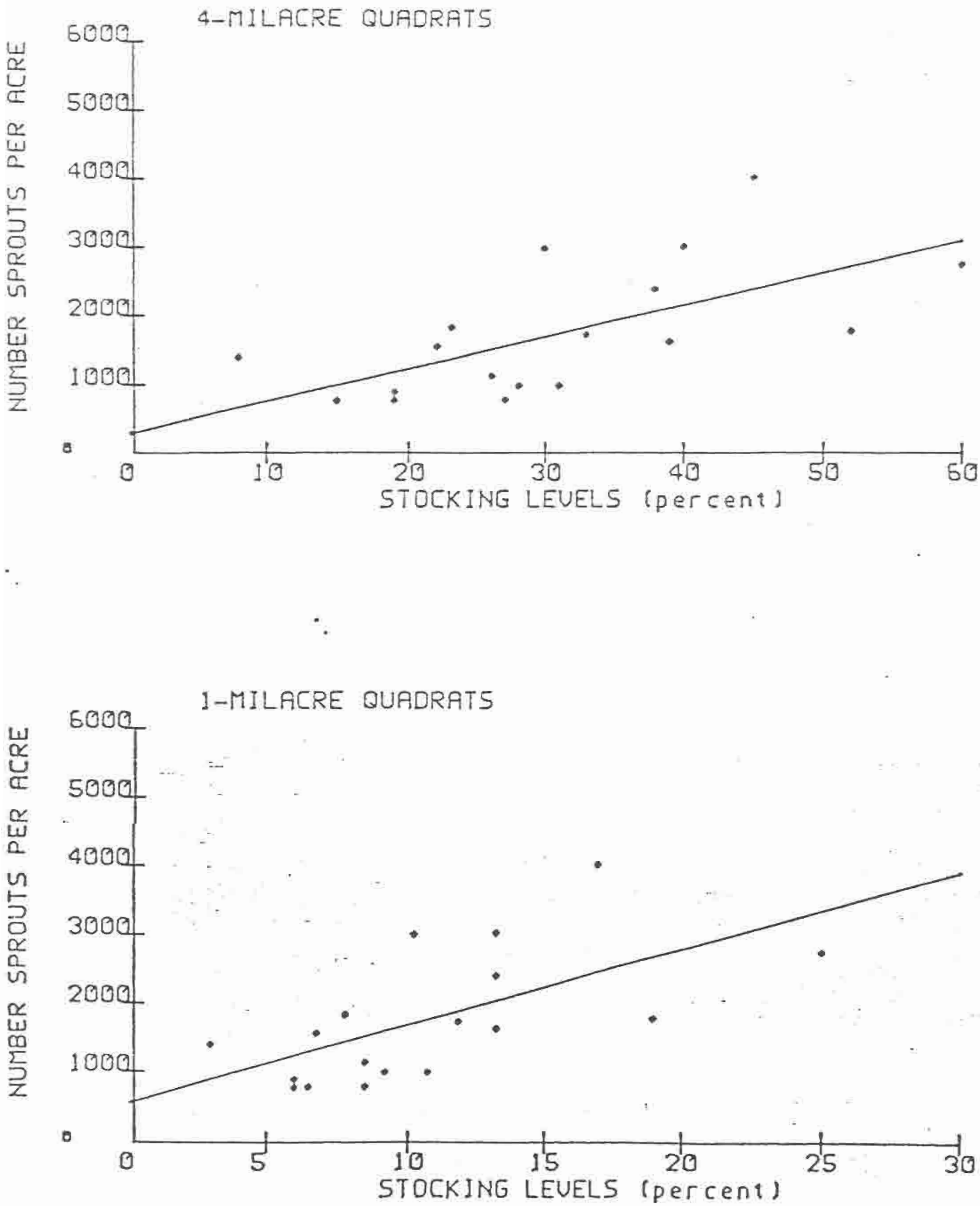


TABLE 2. Summary of the per acre values of sprouting on three sets of six .4 acre plots in the 1985 Hare Creek study.

Plt.	Rwd spt sites	Stumps	Clumps	Sprts	Rwd sprtd (%)	Ave. Ht. (in.)
Block C, clearcut unburned						
		(number/acre)				
1	165.0	170.0	420.0	1627.5	97.1	29.9
2	87.5	87.5	265.0	885.0	100.0	42.9
3	145.0	145.0	332.5	990.0	100.0	34.2
4	105.0	107.5	352.5	1130.0	97.7	39.1
5	117.5	120.0	440.0	1825.0	97.9	42.3
6	157.5	162.5	447.5	1722.5	96.9	44.0
Ave.	129.6	132.1	376.2	1363.3	98.3	38.7
S.D.	31.0	32.5	72.0	408.5	1.4	5.6
Block A Partial cut, unburned						
7	90.0	90.0	180.0	770.0	80.5	22.7
8	100.0	150.0	207.5	780.0	63.3	19.0
9	110.0	147.5	240.0	985.0	85.1	24.2
10	327.5	292.5	695.0	2727.5	97.4	27.3
11	225.0	227.5	482.5	1770.0	92.3	20.5
12	90.0	92.5	202.5	772.5	89.2	21.9
Ave.	157.2	166.7	334.5	1300.8	84.6	22.6
S.D.	98.1	79.4	208.8	798.4	11.9	2.9
Block D. Clear cut, burned						
13	160.0	165.0	467.5	3015.0	96.9	32.0
14	80.0	87.5	277.5	1547.5	91.4	33.5
15	157.5	160.0	540.0	2987.5	98.4	44.5
16	152.5	155.0	410.0	2385.0	98.3	34.6
17	235.0	237.5	837.5	4002.5	98.9	42.9
18	57.5	57.5	227.5	1392.5	100.0	46.8
Ave.	140.4	143.7	460.0	2555.0	97.3	39.0
S.D.	63.7	63.6	218.6	988.9	3.1	6.4
Ave.	142.4	147.5	390.2	1739.7	93.4	33.5
SD	13.9	17.6	63.9	706.8	7.6	9.3

there are no significant differences among the number of sprouts or clumps in the three blocks. The overall view is that, regardless of the silvicultural system or slash treatment, redwood stumps can produce a large number of clumps and sprouts. There is a large number of well established vigorous sprouts within a year of logging.

Note in Table 2 in the partially cut plots that some plots have more sites with sprouts than stumps; some uncut trees have sprouts near the base of the stem.

Average sprout height of the tallest sprout at each site is also shown in Table 2. Average heights and standard deviations of blocks C and D are nearly equal. Average height of block A is about 16 inches less. ANOVA reveals a significant height difference among blocks. The Neuman and Kuels multiple range test (MRT) (Zar,1974) indicates that block A is significantly different from blocks C and D. There is, however, no difference between blocks C and D.

Percent of redwood stumps with established sprouts is also reported in Table 2. The ANOVA of this data reveals a highly significant difference among the percents reported for the three blocks. The Neuman and Kuels (MRT) reveals that the difference is between block A and the two clearcut blocks C and D. There is no difference between the sprouting percentage of the two clearcuts. Clearcut blocks exceed 95 percent sprouted, and the partial cut exceeds 80 percent. Ages of the stands are generally 80-85 years at stump height. Information from a nearby commercially thinned 40-year stand showed 95 percent of the redwood stumps had sprouted. There is no evidence that these older stumps have lost any capacity to sprout heavily. Without plot 8 block A has a sprouting rate of 98 percent, much like that of the clearcut blocks.

Crown sprouting rate

Sprouting was recorded as being at the root collar or higher on the stump. Clumps not directly in contact with the ground were considered as crown. Overall 12.8 percent of clumps and 9.6 percent of the sprouts were called as being of crown origin, Table 3. Analysis of variance of this clump data shows a highly significant difference among blocks. There is a significant difference of sprouts among the blocks. The heaviest crown sprouting is in block C a clear cut with 21 percent of the clumps and 16 percent of the sprouts classed as crown. Lowest incidence of crown sprouting is in block D with clumps at 6.6 and sprouts 4.8 percent. Differences between the two clear cuts may result from burning slash. Crown stumps have a higher risk of loss when the underlying stump tissue fails. Block D was burned six months after logging; this destroyed the initial crop of sprouts. Sampling was delayed until new sprouts had

Table 3. Average number of crown clumps and sprouts per acre for three logged blocks of the Hare Creek sprout study.

Block	Crown clumps/acre			Crown sprouts/acre		
	Ave	SD	Per.of total	Ave.	SD	Per.of total
			(%)			(%)
C	78.3	19.6	20.8	218.8	67.4	16.0
A	41.2	28.7	12.3	117.9	101.6	9.1
D	30.4	29.3	6.6	121.7	101.5	4.8
Total	50.0	25.1	12.8	152.8	57.2	8.8

Table 4. Cumulative percent of redwood stumps and sprout clumps by stump diameter class. Averages for the three blocks are based on six plots per block.

Dia. Class	Rwd clumps BLK C	BLK D	BLK A	Rwd stumps BLK C	BLK D	BLK A
(in.)			(percent)			
1	11.9	9.8	25.3	24.1	21.1	36.7
5	20.3	22.7	33.4	33.1	40.0	43.1
10	28.0	37.6	44.1	41.2	54.0	55.2
15	49.7	60.9	62.6	59.7	72.4	71.0
20	69.5	82.4	76.7	75.2	88.1	82.3
25	83.6	88.6	87.7	86.1	92.9	91.7
30	92.3	95.9	97.9	93.6	97.3	97.2
35	98.6	98.3	99.2	98.5	98.8	98.9
No/ acre	376.2	460.0	334.5	129.6	140.4	161.7

grew, but many burned crown clumps had not resprouted by the fall of 1984.

The total number of clumps in the burned block is 122 percent of the clumps of the unburned block. But, crown clumps in the burned are 39 percent of crown clumps in the unburned. Since there is no difference in stumps per acre there is a strong suggestion that burning has reduced the amount of high risk crown sprouts.

Small stump sprouting

Small diameter stumps are important to the total sprout restocking. The cumulative percent of number of sprouts and stumps by diameter classes are shown in Table 4. About 25 percent of the clumps occur on the 38 percent of the stumps which are 5 inches or less. This portion of the stand contributes to sprout regeneration capacity far beyond its ecomonic value. Stumps larger than 25 inches, the largest 10 percent, have 13.4 percent of the clumps. Only 52 sprout clumps per acre are on 14 largest stumps of the plots.

Whether sprouts growing on the small stumps develop in value as those on larger stumps can be evaluated after a period of time. Small stumps, 1-2 inches, are not likely to be visable after a period of 10-15 years, this makes it difficult to identify tree origin. Tracking sprout locations with maps allows correct attribution of the origin of each stem.

Regressions and correlations

The second objective listed was to determine whether useful relations exist between sprouting levels and stump diameter. These relations are examined by calculation of linear regression and plotting of the data. Pertinent values of the regressions for each of the 18 plots are shown in Table 5. Visual examination of the plotted data and the equation statistics show little evidence of a strong linear trend in most of the plots, seldom do the R values exceed .6. The equations estimate number of clumps or sprouts from stumps diameter. The range of clumps and sprouts for a stump diameter is wide, and it is not possible to make reliable estimates of a stumps response. The average standard error of estimate (SEy) is 1.32 clumps, this is 48.5 percent of the average of 2.81 clumps per stump. For sprouts the SEy averages 64.2 percent of the average of sprouts per stump.

Useful estimates of sprout height cannot be made from stump diameter. Results of linear regression computations (Table 5) show that R seldom is greater than .5, most range from .1 to .3. This level of correlation is low, and does

Table 5. Linear regressions of clumps and sprouts per stump as a function of stump diameter. Height, tallest sprout on each stump, is a function of stump diameter. Information from 18 plots mapped after logging in the Hare Creek 1983 operations of the Jackson Demo. State Forest. Values are: a=intercept; b=slope coefficient; R=corr. coef.

	clmps/stmp			spts/stmp			height/stmp			#No.
Plt.	a	b	R	a	b	R	a	b	R	obs.
1	1.94	.042	.37	7.18	.190	.32	27.9	.141	.10	66
2	1.97	.073	.43	6.83	.228	.32	35.2	.539	.22	35
3	1.66	.083	.57	4.22	.341	.65	24.8	1.281	.68	58
4	1.60	.097	.59	3.55	.397	.51	31.3	.429	.25	42
5	2.09	.109	.50	10.55	.320	.34	31.8	.670	.27	47
6	2.43	.037	.23	5.98	.445	.55	36.3	.693	.31	63
7	1.45	.044	.45	3.50	.402	.64	23.7	-.078	.08	36
8	1.47	.060	.46	4.58	.322	.39	17.6	.145	.14	40
9	1.85	.026	.19	6.65	.187	.25	26.8	-.208	.17	44
10	1.43	.091	.51	5.52	.398	.41	23.2	.525	.27	131
11	1.60	.060	.41	4.45	.379	.47	18.6	.212	.19	90
12	1.51	.047	.37	5.36	.207	.37	19.7	.135	.10	36
13	1.98	.112	.55	9.69	1.09	.59	27.0	.603	.11	64
14	2.50	.062	.31	10.65	.551	.33	32.7	.094	.05	32
15	1.86	.132	.74	4.44	1.23	.63	29.9	1.24	.53	63
16	2.02	.079	.43	8.47	.855	.65	26.8	.934	.44	61
17	1.57	.212	.85	4.92	1.29	.83	29.1	1.47	.66	94
18	2.24	.116	.71	6.60	1.19	.82	34.1	.862	.46	23

Table 6. Linear regressions and correlations of relations of sprouting and stand values of the Hare Creek sprout study of 1985. Values are per acre and computed from data of 18 plots shown in tables 1 and 2. a=intercept, b=slope, R=correlation coefficient, N=number

No.	Dep.var.	Indep.var	a	b	R	No
1	No.Clmps.	% stkd. 1mil.	104.58	26.288	.798	18
2	No.Spts.	% stkd. 1mil.	565.05	108.099	.619	18
3	No.Clmps.	% stkd. 4mil.	69.45	10.404	.774	18
4	No.spts.	% stkd. 4mil.	375.03	44.260	.622	18
5	No.Clmps	#rwd stmps	31.34	2.4335	.823	18
6	No.Spts.	#rwd stmps	250.01	10.0998	.645	18
7	No.Clmps	#sptd sites	65.99	2.2779	.858	18
8	No.Spts.	#sptd sites	394.41	9.4500	.673	18
9	No.Crown	#rwd stmps	35.04	.0857	.286	18
10	No.Clmps.	#rwd stmps	5.22	2.9938	.901	12
11	No.clmps	#sptd sites	9.48	3.0270	.903	12

not give confidence in estimates of height from stump diameter. Plotting the data shows that heights associated with a specific stump diameter are too variable. Most regression lines are nearly horizontal, but for two plots sprout heights decrease as diameters increase.

Numbers of sprouts

Testing the plot data for relations to describe stand sprout response looks at the number of redwood stumps, and the number of sites with sprouting. Most redwood stumps in the clearcut blocks have sprouted, but response in the partial cut block is not as clear. Equations which show some of the response are summarized in Table 6, with graphic displays shown in Figures 6 and 7. Clumps are better correlated than number of sprouts with the variables tested. Correlation of clumps to the number of sprouted sites improves over that of correlation to redwood stumps. Most of the difference results from conditions in block A. The number of redwood stumps and sprout sites in the clearcut blocks are essentially the same. But the partial cut has one plot with a low stump sprouting rate and all plots have uncut sprouted stems.

Separate equations for number of clumps in the two clearcut blocks are shown in Table 6. The conditions are similar in that there are no trees left to influence the sprouting patterns. Variability is much less in these 12 plots and the R is higher. Estimates of sprouting in stands to be clear cut might be more appropriate using these equations.

Estimates of sprouting are most reliable from the number of sites with sprouts. However, the number of redwood stumps can be directly determined by sampling. Estimates of the number of sprouted sites can be made by multiplying the number of redwood stumps by the 96 percent rate of sprouting.

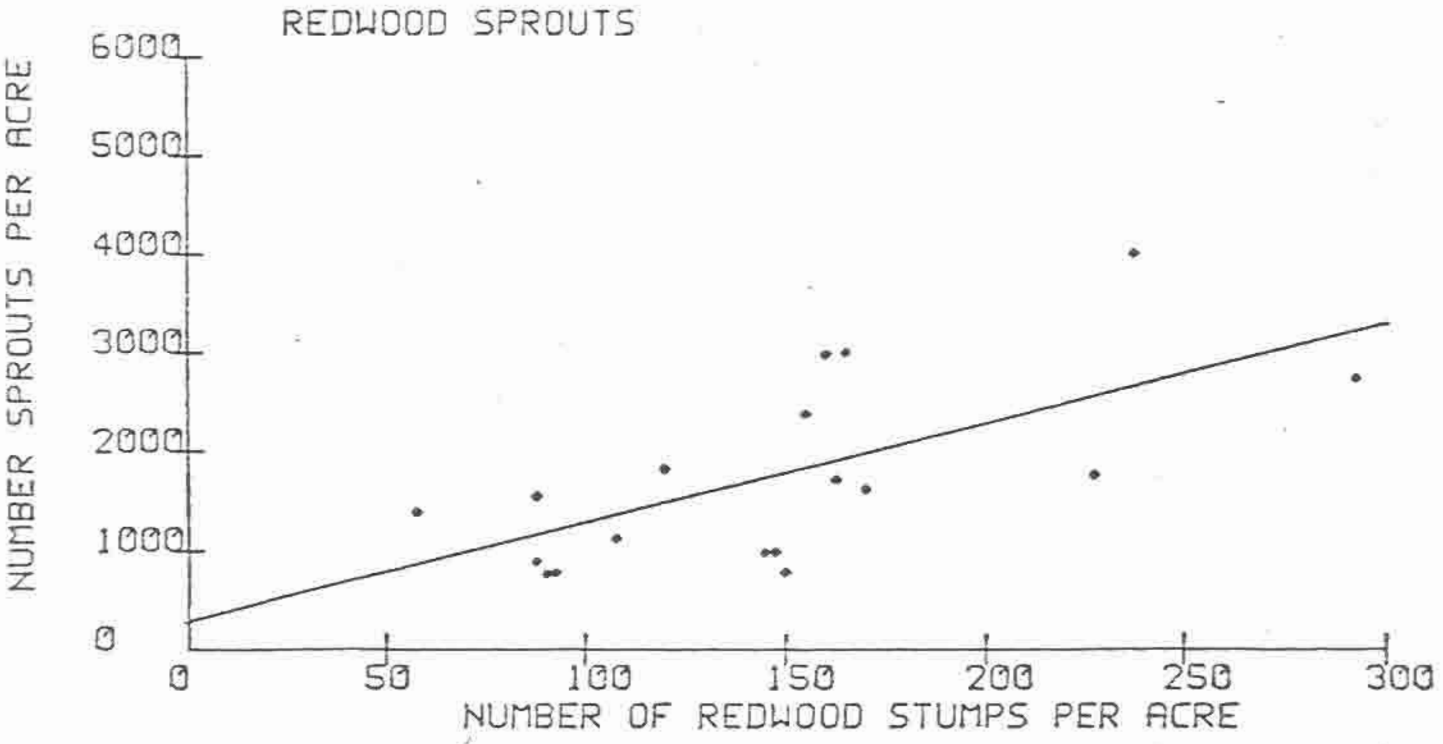
Slash burning

Slash burning did not reduce the total amount of sprouting in any way that seriously affects stocking. Some initial crown clumps did not resprout after the burn, but this reduction of high risk crown clumps is beneficial. However, an important difference between blocks C and D may be the heavy thicket of Ceanothus and Arctostaphylos seedlings in the burned block. How this brush competetion develops should be monitered to determine it's effect on natural sprouting and planted seedlings.

SUMMARY AND CONCLUSIONS

Stocking by sprouts in milacre quadrats in these

FIGURE 6. Sprouts and clumps per acre over the number of redwood stumps for 18 plots of the Hare Creek study 1984.



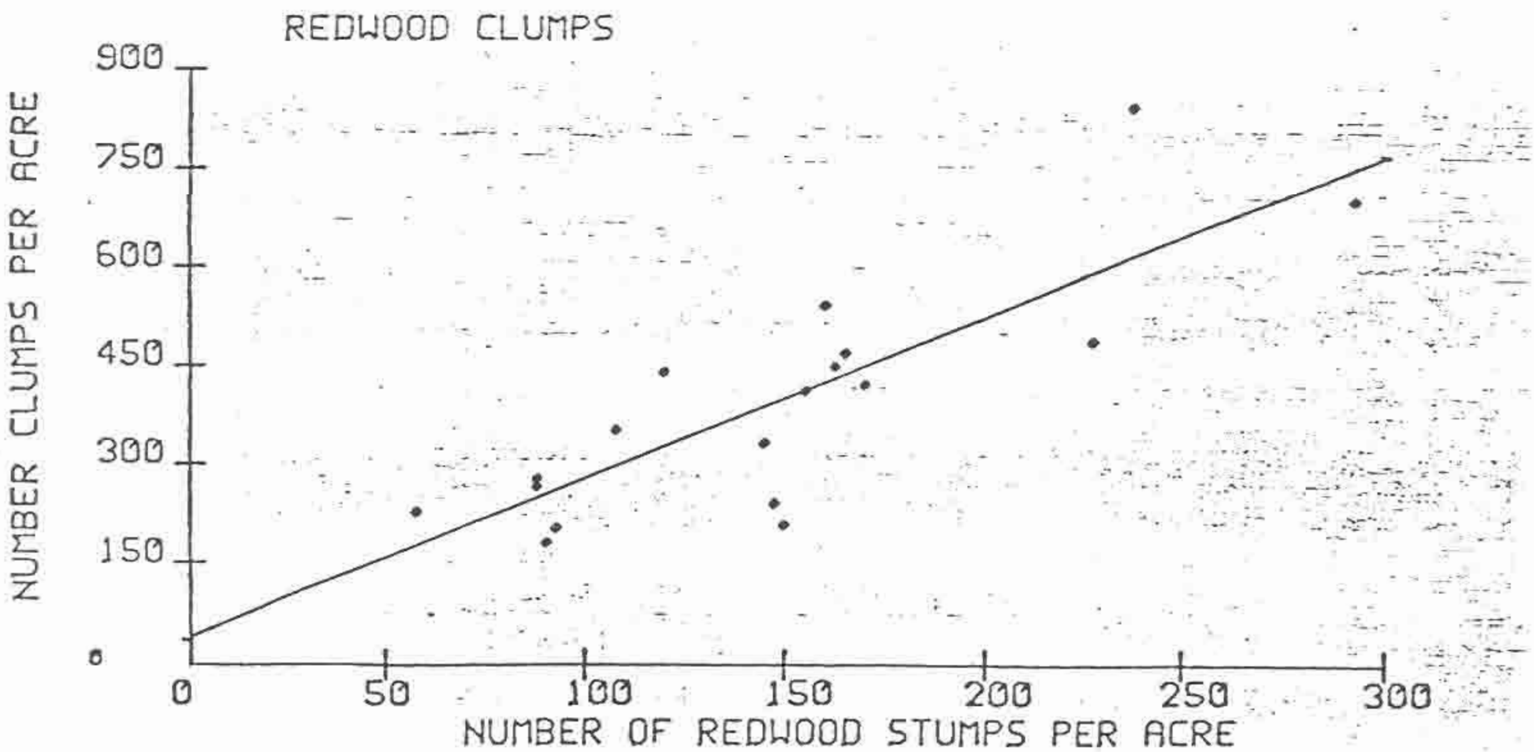
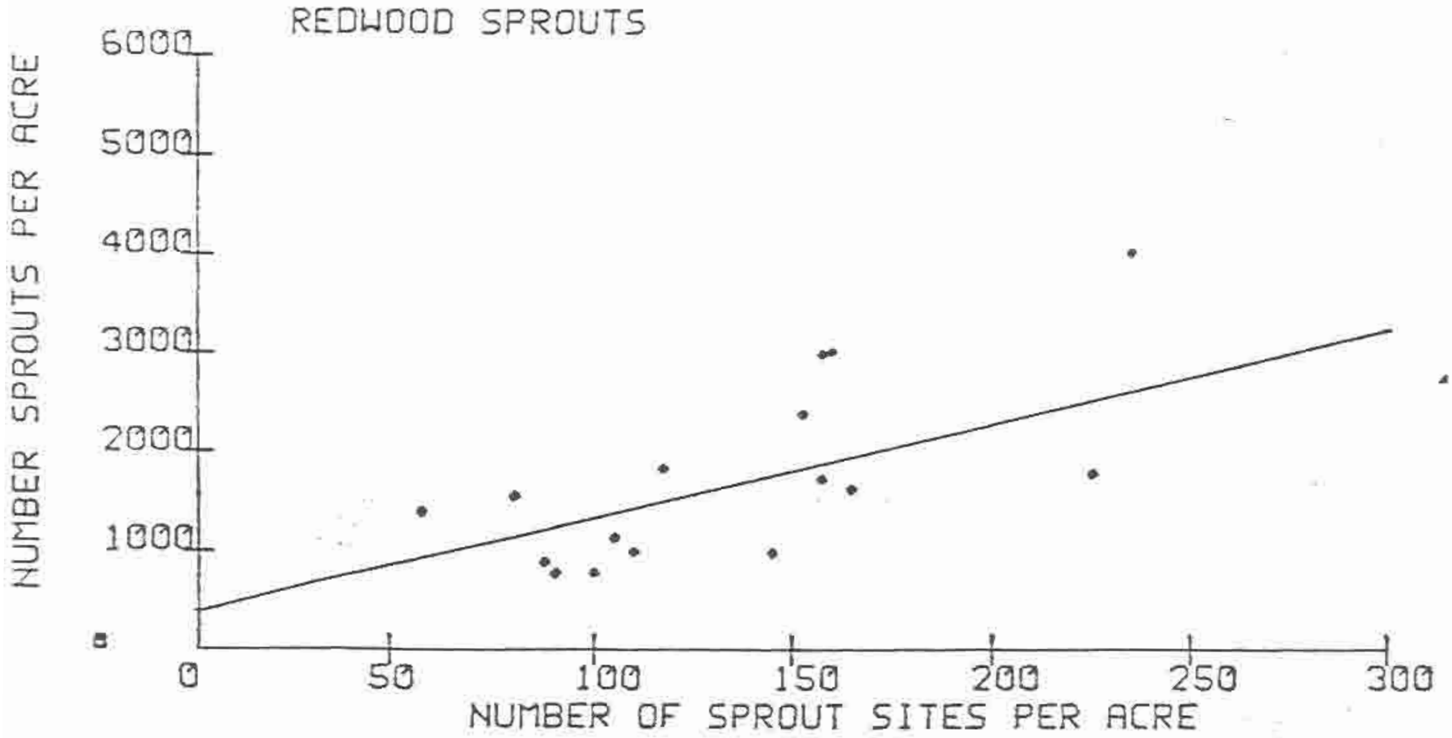
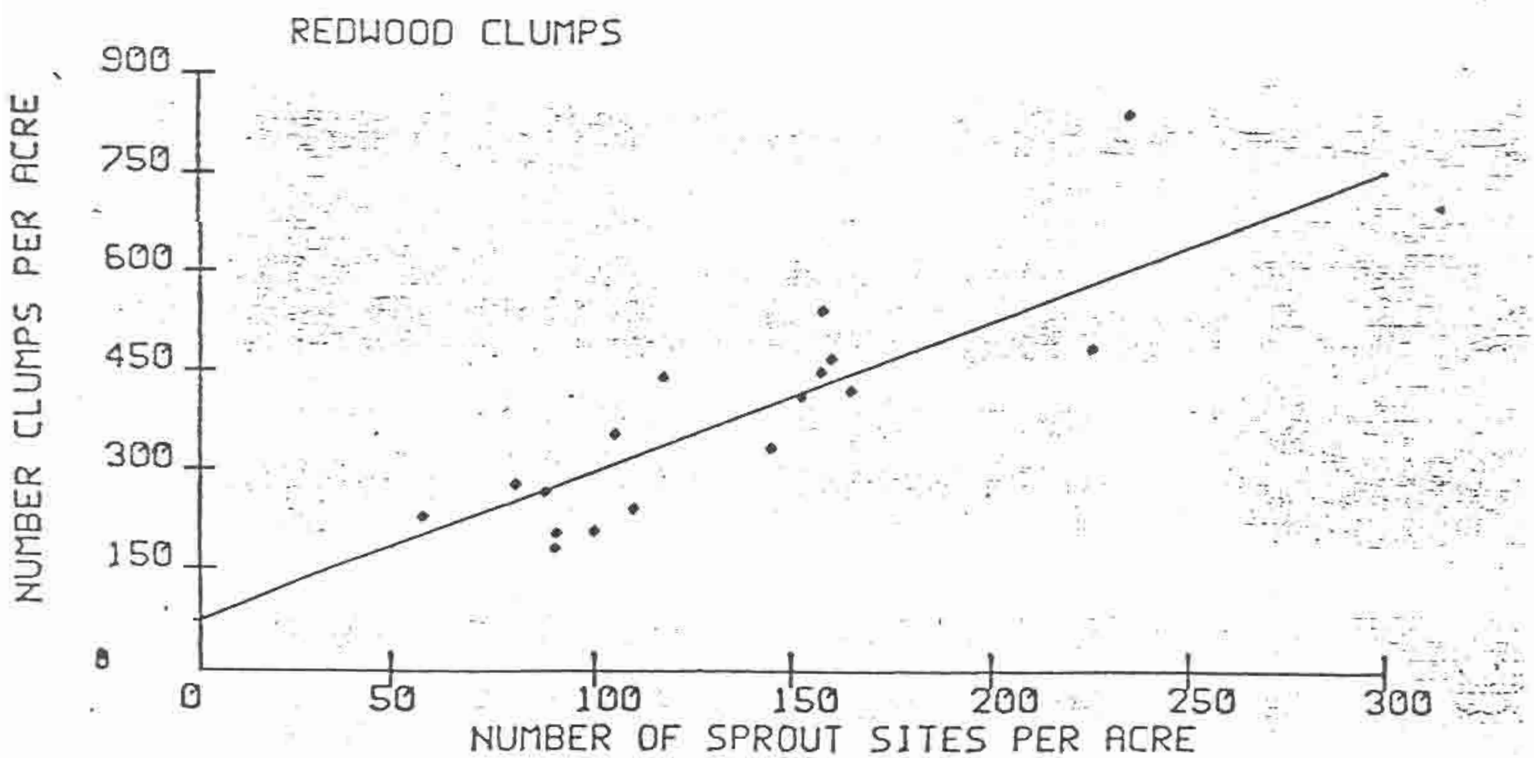


FIGURE 7. Sprouts and clumps per acre over the number of sprouted sites for 18 plots of the Hare Creek study 1984.





second-growth stands is not much different than reported in 1942. However, the numbers of clumps and sprouts suggests a robust fast growing sprout population that could be a stand of 400 established trees per acre in a few years. This sprout population may not have the best spatial distribution that management would like. Some additional interplanting of redwood or Douglas-fir may be required to stock obvious openings. Clearly, you should not depend on a simple value of milacre stocking to describe the sprout population. If we assume one established stem per clump in 20 years the stocking of the 4-milacre quadrat is a more useful measure of site occupancy. The 31 percent stocking means 77 quadrats with an average of 5.1 established stems.

Redwood averaged 60 percent of the total number of stumps in the blocks, and sprout regeneration averages 390 clumps with 1739 sprouts per acre. Average height of the tallest sprout at each sprout site is nearly 3 feet, and about 90 percent sprouts are root collar origin. There is an aggressive well established regeneration component in place that is vital to the final crop. Estimates of the sprout regeneration can be from the equations shown in Table 6. ~~While~~ the number of individual sprouts is constantly in flux; but we can assume at least one well established stem per clump site. Number of redwood stumps is the most useful measure for making predictions of sprout regeneration. The most valuable use of the estimates is to plan the planting to meet desired stocking levels. Planting has to be monitored so that it improves the distribution of the new stand at least cost.

without burning ?

Small suppressed redwood are often overlooked, but they have a vital role in the sprout restocking of logged sites. Nearly 25 percent of the clumps were on stumps 5 inches or less. There appears to be no difference in the vigor of sprouts between small stumps and large stumps. It is important that small suppressed stumps be recognized and included in sampling the redwood stump component.

There is little to gained by using the prediction equations of clumps or sprouts per stump from stump diameter (Table 5). Most stumps sprout; but the correlation of sprouting to stump diameter is poor, and of limited utility. Sprout heights are also poorly correlated to stump diameter, and the equations have little practical value. It is sufficient to know that in the first growth season many of these vigorous sprouts will reach 4.5 feet.

in old growth the larger stumps have a lower sprouting % than 2nd growth stumps

RECOMMENDATIONS

Specific ideas about the sprout population revealed in this study lead to some specific operational suggestions. The main notion of these recommendations is that the sprout population will develop into a vigorous component of the next stand. It is expensive and unwise to not consider the impact of the native sprout population on management activity. Costs of planting are high, and unnecessary trees should not be part of restocking activity.

1. Sample cut blocks to determine the number of redwood stems, take care to sample the small redwood down to the 1 inch class.
2. Estimate the number of clumps per acre to expect on the existing redwood. These estimates will help the ordering of seedlings from the nursery.
3. Work closely with planting operators to develop an understanding of how to adjust planting patterns to existing sprout populations.
4. If planting Douglas-fir they should not be planted close to the heavy clumps of sprouts.
5. Evaluate effects of burning on the degree of brush competetion ~~on~~ planted seedlings. In block D a year after the burn a very heavy carpet of brush is in place

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